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Gambier as a Catch-Crop with Oil Palm.

C. D. V. Georgi,
Ag. Agricultural Chemist
and
E. A. Curtler,
Assistant Agriculturist.

Introductory.

Among possible catch-crops for cultivation with oil palms may be mentioned gambier (*Uncaria Gambir*, Roxb.) with which an investigation is being carried out at the Government Plantation, Serdang.

Since the experiments are still in progress the paper only records the yields of gambier harvested to-date, special reference being made to those obtained during a period of two years as a result of harvesting the plants at varying intervals.

Further, it is not yet possible to judge the ultimate effect of the catch-crop on the oil palms, since the latter are between 4 and 5 years old and have only recently commenced to bear fruit.

Description of Experiment.

The area for the experiment comprises one acre, Plot G of Series 3, in a 45-acre block of oil palms, Block 21. The land is flat and the soil consists of a shallow clay-loam overlying a sandy sub-soil.

The oil palms were planted during the early part of 1925, 28 feet x 28 feet triangular, this arrangement giving 63 palms per acre.

The gambier was raised from seed planted in shaded nursery beds and transferred to the field during November 1925, when the seedlings were from 3 to 4 inches high.

Three rows of gambier were planted in the avenues between the palms, the approximate width of an avenue being 24 feet. The rows of gambier were spaced 6 feet apart with the same distance between the plants in the rows. This arrangement allowed at least 6 feet between either any two gambier plants or the outer row of gambier and the adjacent row of palms.

Such a scheme of planting allows 828 plants per acre, compared with 1210 plants if the gambier had been a sole crop.

A diagrammatic representation of the plot is given on page 383.

Harvesting.

No cultivation has been undertaken since the gambier was planted except routine weeding and the return of the prunings as a mulch to the soil.

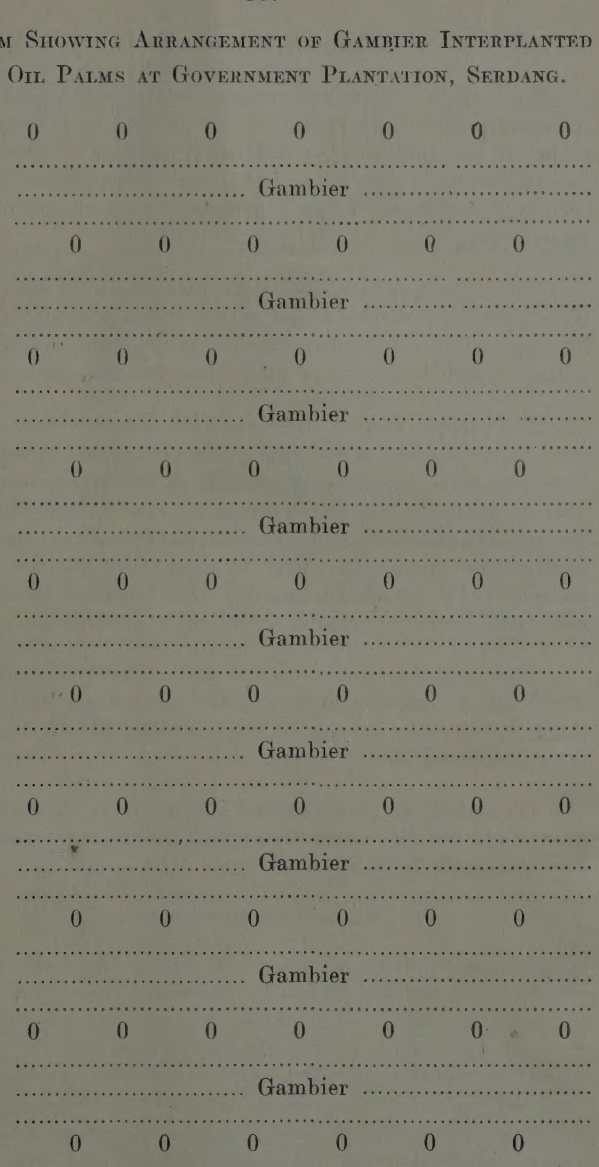
Harvesting commenced towards the end of October 1926, that is rather less than one year after planting in the field.

The method of harvesting is to top all main shoots as soon as they exceed 6 feet in height and to remove all side shoots, leaving only the pair of leaves next to the main shoot. An exception is made in the case of the side branch nearest the top of the main shoot on the outside of the plant, this branch being left as a leader.

At the commencement of the experiment the average number of stems was 6 per plant, but at the close of the second year this had been reduced to 3 per plant owing to a certain number of stems having been removed from time to time.

When harvesting gambier cutting should be delayed until the leaves are free from surface moisture. If the moist leaves are stacked for even a short period rapid discolouration ensues with consequent deterioration of product. In the case of the present investigation therefore arrangements were made not to commence harvesting until between 11 a.m. and 12 noon.

Diagram Showing Arrangement of Gambier Interplanted with Oil Palms at Government Plantation, Serdang.



0 = Oil palm. . = Gambier.

Periodic Harvesting.

Since little definite information is available regarding the optimum period of harvesting it was decided in February 1927 to utilise the plot for the additional purpose of ascertaining the variations in yields between harvesting after different periods, those chosen being 3 months, 4 months and 6 months respectively.

Since the gambier had been planted in 9 avenues and there were three periods of harvesting it was possible to arrange for three groups to be harvested at each period, a group consisting of the three rows of plants between two rows of palms.

The groups were so arranged that between any two harvested after a given period there were always two groups which were due to be harvested after each of the other two periods. This is illustrated in the diagram referred to previously, the groups A1, A2, A3 being harvested after three months intervals, the groups B1, B2, B3 after four months and the groups C1, C2, C3 after 6 months. The object of this arrangement was to reduce possible effects of soil variations.

After periodic harvesting had been carried on for one year it was found necessary to remove the two outer rows from each group in the plot owing to the gambier plants obstructing the development of the palms.

The details for the numbers of the plants in the different groups and the figures for the annual yields of the fresh prunings are shown in Table I.

Method of Extraction.

A representative sample of 30 lbs of the fresh prunings was weighed and despatched by passenger train from Serdang to Kuala Lumpur. The bundle was received at the Department of Agriculture on the same afternoon, and the prunings spread on the floor of the laboratory till the following morning. The prunings were finely chopped and the mass weighed in order to ascertain the loss due to evaporation of moisture. The chopped material was then quartered and two samples, each weighing 5 lbs., taken for the determination of the gambier content.

In this connection it may be mentioned that the average loss between the weight of the fresh prunings and that of

TABLE I.

Annual Yields of Fresh Gambier Prunings at Government Plantation, Serdang.

Period betwen harvesting. months.	Details for individual groups.									Annual yields from series of groups.	
	Group No.	No. of plants.	Weight of fresh prunings. lbs.	Group No.	No. of plants.	Weight of fresh prunings. lbs.	Group. No.	No. of plants.	Weight of fresh prunings. lbs.	No. of plants.	Weight of fresh prunings. lbs.
A. First year, Feb. 1927–Feb. 1928, plants $1\frac{1}{4}$—$2\frac{1}{4}$ years old.											
3 months -	A1	92	1931	A2	92	1348	A3	87	1259	271	4538
4 months -	B1	89	1628	B2	82	1374	B3	89	1269	260	4271
6 months -	C1	91	1381	C2	85	1182	C3	83	1237	259	3800
B. Second year, Feb. 1928–Feb 1929, plants $2\frac{1}{4}$—$3\frac{1}{4}$ years old											
3 months -	A1	30	512	A2	31	452	A3	29	461	90	1425
4 months -	B1	30	535	B2	29	502	B3	28	524	87	1561
6 months -	C1	29	526	C2	28	517	C3	27	520	84	1563

the chopped material the following morning was 20 per cent. Further, it would appear that the moisture content of the fresh prunings is approximately 70 per cent.

The sample of chopped material was boiled gently for 30 minutes with 2 gallons of water in a steam-jacketed pan, the mass being turned over constantly during the process. The liquid was decanted through a coarse strainer and a further gallon of water added, the boiling being continued for 15 minutes. The liquid from the second boiling was poured through the strainer and mixed with that from the first boiling. The process was repeated a third time, one gallon of water being used and the boiling continued for 15 minutes. The exhausted prunings were thrown away and the bulked extracts returned to the pan and evaporated gently until rather less than 2 litres remained. The liquid was cooled, made up to 2 litres, filtered through a coarse paper and an aliquot portion of the filtrate evaporated to dryness, the residue being dried to constant weight at 100°C. The average of the figures for the two samples was used as the basis for the calculation of the moisture-free gambier content of the material.

It may be mentioned here that the method of calculating the gambier content on this basis was adopted on account of the wide variations found in the moisture content of the marketable product.

As pointed out in a previous article on the subject in this Journal, compare "Gambier (*Uncaria Gambir*), Its Extraction and Valuation", B. J. Eaton and R. O. Bishop, Vol. XIV, No. 2, February 1926, page 37 the above method is not the most satisfactory from the point of view of the preparation of first quality gambier. The reason for its adoption was, however, to follow as far as possible the method which would be used on an oil palm estate where the gambier was being cultivated as a catch-crop and where the management would be unwilling to incur a heavy outlay on an extraction plant.

The results of the separate determinations for the samples examined from each group are given in Table II. In order to make the latter as concise as possible only the minimum, maximum and average figures have been shown.

Remarks and Conclusions.

The results of the investigation to-date show that unless the gambier is established at the same time as the oil palms

TABLE II.

Moisture-free Gambier Content of Fresh Cuttings from Government Plantation, Serdang.

Group No.	Interval between harvesting.	Moisture-free gambier content.			
		Minimum.	Maximum.	Average.	Average for series of groups.
	months.	per cent.	per cent.	per cent.	per cent.
A. First year, Feb. 1927–Feb. 1928, plants $1\frac{1}{4}$ —$2\frac{1}{4}$ years old.					
A1	3 months	6.6	7.4	6.9	
A2	do.	5.8	7.3	6.6	6.7
A3	do.	5.7	7.9	6.5	
B1	4 months	6.2	6.9	6.6	
B2	do.	6.4	7.5	7.0	7.0
B3	do.	7.1	7.6	7.4	
C1	6 months	6.3	6.7	6.5	
C2	do.	6.9	7.5	7.2	6.8
C3	do.	6.3	7.0	6.7	
B. Second year, Feb. 1928–Feb. 1929. plants $2\frac{1}{4}$ —$3\frac{1}{4}$ years old.					
A1	3 months	6.0	6.6	6.3	
A2	do.	6.1	7.3	6.6	6.4
A3	do.	5.3	7.2	6.3	
B1	4 months	6.1	8.4	7.2	
B2	do.	6.3	7.9	7.0	7.3
B3	do.	6.5	9.1	7.8	
C1	6 months	6.1	6.2	6.2	
C2	do.	6.4	6.9	6.7	6.3
C3	do.	5.6	6.2	5.9	

a considerable proportion, amounting in the present instance to two-thirds of the total number of plants, has to be cut out at an early date owing to the gambier obstructing the development of the palms.

Although therefore from the point of view of revenue from the catch-crop it would appear desirable to establish the gambier before the oil palms this practice would entail an additional heavy charge for the upkeep of the catch-crop, also the presence of the gambier on the land would impede the planting of the palms.

Further, the regular planting arrangement adopted in this experiment would in all probability be impracticable under estate conditions, although it is considered that the number of plants, 828 per acre, represents an average stand for gambier as a catch-crop under such circumstances.

Although the differences between the weights of fresh prunings for the separate years of the periodic harvesting experiment are not significant, the figures for the analysis of the extracts indicate an optimum period of cutting at intervals of about 4 months. It will be noticed that in both years the yields of gambier are greatest in the case of the groups harvested after this interval.

A further table, Table III, is given in which the figures for the calculated yields of moisture-free gambier during the two years of the experiment have been entered.

In view of the fact that such a large proportion of the gambier plants was removed at the end of the first year of the experiment the results for the two years cannot be considered comparable and the figures are therefore only of value from the point of view of recording the calculated amounts of moisture-free gambier for the series of groups during the individual years.

In this connection also it may be of interest to record the calculated total yields of moisture-free gambier for the various series of groups from the commencement of harvesting operations.

TABLE III.

Calculated Annual Yields of Moisture-free Gambier at Government Plantation, Serdang.

Period between harvesting. months.	Details for individual groups.									Annual yield from series of groups.	
	Group No.	No. of plants.	Weight of moisture-free gambier. lbs.	Group No.	No. of plants.	Weight of moisture-free gambier. lbs.	Group No.	No. of plants.	Weight of moisture-free gambier. lbs.	No. of plants.	Weight of moisture-free gambier. lbs.
A. First year, Feb. 1927—Feb. 1928, plants $1\frac{1}{4}$ — $2\frac{1}{4}$ years old.											
3 months -	A1	92	133.6	A2	92	89.7	A3	87	84.9	271	308.2
4 months -	B1	89	109.9	B2	82	95.7	B3	89	93.5	260	299.1
6 months -	C1	91	89.7	C2	85	84.3	C3	83	81.1	259	255.1
B. Second year, Feb. 1928—Feb. 1929, plants $2\frac{1}{4}$ — $3\frac{1}{4}$ years old.											
3 months -	A1	30	32.2	A2	31	29.9	A3	29	28.8	90	90.9
4 months -	B1	30	38.8	B2	29	35.3	B3	28	40.7	87	114.8
6 months -	C1	29	32.3	C2	28	34.3	C3	27	30.5	84	97.1

Details of groups.	Calculated yields of moisture-free gambier.			
	Oct. 1926 to Feb. 1927.	Feb. 1927 to Feb. 1928.	Feb. 1928 to Feb. 1929.	Total.
	lbs.	lbs.	lbs.	lbs.
A1, A2, A3. -	98.3	308.2	90.9	497.4
B1, B2, B3. -	96.5	299.1	114.7	510.3
C1, C2, C3. -	95.0	255.1	97.1	447.2
			Total for plot	1454.9

The figures in the above table indicate that the calculated amounts of moisture-free gambier for the different groups vary only from 447 to 510 lbs., the total amount for the whole plot up to the conclusion of the second year of periodic harvesting being approximately 1455 lbs.

Although not coming within the scope of this paper it may be of interest to mention that assuming the gambier to have been planted as a sole crop the results of the periodic harvesting for the first year, during which period the plot contained the original stand of plants, indicate a total yield of fresh prunings amounting to approximately 19,500 lbs. (147 piculs) per acre, which corresponds to a yield of approximately 1330 lbs. (10 piculs) of moisture-free gambier per acre.

It will be realised that the figure for the amount of moisture-free gambier, which is based on the method of extraction previously described, approximates to a theoretical yield, which would not be obtained in ordinary practice. With such a comparatively simple process however it appears reasonable to assume that 90 per cent. of the soluble solids would be recovered, thereby reducing the figure for the yield of moisture-free gambier obtained under estate conditions to approximately 1200 lbs. (9 piculs) per acre.

Summary.

1. The present paper records the results of an investigation extending over a period of two and a half years regarding the cultivation of gambier as a catch-crop with oil palm.

2. The yields of both fresh prunings and moisture-free gambier obtained during this period are given.

3. The results of a periodic harvesting experiment appears to indicate that the optimum period for harvesting is at intervals of 4 months.

4. The investigation is still in progress and further results will be reported at the end of a further year's work.

In conclusion, the writers wish to record their appreciation of the share of the work performed during the first year of the investigation by Mr. R. O. Bishop, the former Acting Agricultural Chemist.

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Kepayang Oils.

C. D. V. Georgi,
Ag. Agricultural Chemist
and
Gunn Lay Teik,
Assistant Analyst.

Introductory.

Kepayang is the Malay name for the oils obtained from the seeds of two different plants, *Pangium edule*, Reinw. and *Hodgsonia capniocarpa*, Ridley. The former is a tall spreading tree belonging to the Natural Order, Flacourtiaceae, while *Hodgsonia capniocarpa* is a forest creeper which belongs to the Natural Order, Cucurbitaceae.

Pangium edule is known as pokok kepayang to differentiate it from *Hodgsonia capniocarpa* which is called akar kepayang, although according to Gimlette (1) the more correct name for the latter is akar klapayang.

Accounts have been given in two previous numbers of this Journal, Vol. II, 1913-1914, No. 3, page 67 and Vol. XI, 1923, No. 2, page 39 of the oil from the *Hodgsonia* species, the oil from *Pangium edule* has not previously been investigated in the Department. In the second article referred to above the results of an analysis of a sample of fruits alleged to be *Pangium edule* are recorded but, since the oil content of the kernel was so low and there was insufficient oil for a determination of the physical and chemical characteristics, the figures must be regarded as inconclusive.

Since a further enquiry was received recently regarding the possibility of the utilisation of kepayang oil on a commercial scale the investigation has been repeated, authentic specimens of both fruits being kindly supplied for the purpose by the Forest Department.

(1) Gimlette J.D. Malay Poisons and Charm Cures, page 140.

Pokok Kepayang (*Pangium edule*, Reinw.)

The fruits are oblong-ovoid in shape and vary from 7 to 12 inches in length and 4 to 6 inches in cross-section. The fresh ripe fruit weighs from 3 to 4 lbs. The rind of the fruit is brown in colour, woody and wrinkled.

The fruits may contain from 20 to 30 seeds, which are embedded in a slimy pulp. This pulp darkens rapidly on exposure to air, doubtless owing to the presence of a tannin.

The individual seeds are brownish in colour and approximately triangular in shape, they are about 2 inches long. The veined shell is thin, tough and is approximately $\frac{1}{8}$ inch in thickness.

The kernel is white in colour but, similar to the pulp, darkens rapidly on exposure to air.

Oil Content of Seeds.

The results of analysis are shown in the following table:—

Seed.		grammes.
Average weight of seed	...	14.4
Average weight of kernel	...	8.7
		per cent.
Proportion of shell	...	39.3
Proportion of kernel	...	60.7
		100.0
Kernel.		
Moisture (loss at 100°C)	...	4.5
Oil (petroleum ether extract)	...	24.8
Residue (by difference)	...	30.7
		100.0
Oil (calculated on moisture-free basis)		44.7
Oil (calculated on whole seed)	...	14.8

Analytical Constants of Oil.

Owing to the small number of seeds available it was not possible to prepare by expression a sufficient quantity of the oil for the determination of the more important analytical constants. The kernels were therefore shredded, dried and solvent extracted with petroleum ether.

The oil was yellow in colour and had a somewhat pleasant odour.

The average results of duplicate determinations of the more important analytical constants are shown in the following table.

Oil.

Specific gravity at 30°C (water at 15.5°C = 1)	...	0.9132
Refractive index at 30°C	...	1.4660
Saponification value	...	196.5
Iodine value (Wijs)	...	108.3
Acid value	...	0.2
Unsaponifiable (per cent.)	...	0.6

Fatty Acids.

Solidifying Point (Titer value)	...	20.4°C
Mean molecular weight	...	280.3
Iodine value (Wijs)	...	111.1

Remarks and Conclusions.

The results of analysis show that the oil content of the kernels, calculated on a moisture-free basis, is approximately 45 per cent., equivalent to about 15 per cent. on the fresh seeds.

The figure for the iodine value of the oil indicates that the latter belongs to the class known as semi-drying oils.

An interesting feature of the oil is that it is optically inactive. This is all the more surprising since the genus *Pangium* is closely allied to the genus *Hydnocarpus*, both belonging to the same Natural Order, and the optical activity of the oils from seeds of the genus *Hydnocarpus* is well-known.

During the preliminary drying of the kernels an odour of hydrocyanic acid was noticeable. According to Gimlette (2) this has been observed by previous investigators, notably Greshoff, who showed the presence of a cyanogenetic glucoside. In this connection also it may be mentioned that the toxic properties of the fresh seeds are well-known to the Malays who have been known to use both the freshly crushed seeds and the oil from such seeds as poisons.

The presence of the glucoside would therefore cause the seeds to be regarded with a certain amount of suspicion, since special treatment would be required to ensure the oil being non-poisonous.

An additional interesting feature of the kernel is the presence of a tannin causing an intense darkening of the material on drying.

Akar Kepayang (*Hodgsonia capniocarpa*, Ridley)

The fruits are similar in shape to small melons, being approximately 6 inches in diameter and 4 inches high, A fresh ripe fruit weighs from 2 to 3 lbs.

The rind of the fruits is dark greyish-green in colour and smooth, the surface being however marked by small globular depressions.

The individual fruits contain from 4 to 6 seeds, the latter being embedded in a slimy pulp. The fresh seeds form approximately 20 per cent of the weight of the ripe fruit.

The seeds are buff in colour, ellipsoid in shape and flat, the surface being marked by sunken veins. The shell is tough, woody and is approximately $\frac{1}{8}$ inch in thickness. The seeds are about 3 inches long and from $1\frac{1}{2}$ to $1\frac{3}{4}$ inches wide.

The kernels, which are covered with a thin layer of spongy tissue, are yellowish-white in colour, soft and oily.

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(2) Gimlette J.D, Malay Poisons and Charm Cures, page 202.

Oil Content of Seeds.

The results of analysis are shown in the following table:—

Seed.	grammes.
Average weight of seed	... 29.0
Average weight of kernel	... 9.6
	per cent.
Proportion of shell	... 55.0
Proportion of spongy layer	... 12.0
Proportion of kernel	... 33.0
	100.0
Kernel.	
Moisture (loss at 100°C)	... 46.3
Oil (petroleum ether extract)	... 35.7
Residue (by difference)	... 18.0
	100.0
Oil (calculated on moisture-free basis)	... 66.5
Oil (calculated on whole seed)	... 11.8

Analytical Constants of Oil.

The fresh kernels were dried in order to reduce the moisture content. They were shredded and the mass pressed in the small laboratory hand-press.

A faint odour of hydrocyanic acid was noticed during the early stages of drying, indicating the presence of a glucoside similar to that present in *Pangium edule*.

The oil is light yellow in colour with a pleasant nutty odour. After standing for a few days a small quantity of stearin separates.

The following table gives the average results of duplicate determinations of the physical and chemical characteristics of the oil, the figures for the sample examined previously being added for purposes of comparison.

Oil.	Present sample.	Previous sample.
Specific gravity at 30°C (water at 15.5°C = 1) ...	0.907	0.922 20°C)
Refractive index at 30°C ...	1.4613	1.4694 (20°C)
Saponification value ...	201.2	203.9
Iodine value ...	67.1	63.6
Acid value ...	3.6	5.6
Unsaponifiable (per cent.) ...	0.4	

Fatty Acids.		
Solidifying point (Titer value)	42.1°C	40.8°C
Mean molecular weight ...	272.6	272.7
Iodine value ...	68.2	61.9

Remarks and Conclusions.

The results of analysis show that the oil content of the kernels, calculated on a moisture-free basis, is approximately 66.5 per cent. This figure compares favourably with that obtained on the previous occasion, 65.6 per cent.

The figures for the physical and chemical characteristics of the oil and the fatty acids, which are in close agreement with those published previously, show that the oil is entirely different in character from that obtained from *Pangium edule*. The iodine value of the oil indicates that it belongs to the non-drying class.

Utilisation of Kepayang Oils.

Since neither plant has been cultivated under estate conditions and there is no reliable information available with regard to the yield of fruit it is not possible to give an idea of the economic possibilities.

It is true that the oils are used by the Malays as a substitute for coconut oil for cooking purposes but, since the crop in each case is definitely seasonal and neither oil appears to possess any special feature to enhance its value, it is extremely unlikely that the cultivation of the crop on an estate scale will be undertaken. Further, it must be remembered that it would also be necessary to subject the kernels to special treatment before extraction in order to obviate the presence of any glucosidal principle in the oil.

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The Destructive Distillation of Coconut Shells and Oil Palm Nut Shells.

C. D. V. Georgi,
Ag. Agricultural Chemist
and
T. A. Buckley,
Forest Chemist.

The present paper describes certain experiments carried out at the Department of Agriculture regarding the destructive distillation of the shells of nuts from the coconut palm and the oil palm.

The work was originally undertaken with the idea of investigating the possibility of utilising the surplus amounts of coconut shells on some estates but in view of the fact that the oil palm fruit contains a similar constituent it was decided to extend the experiments to include oil palm nut shells.

With regard to the latter, surplus amounts of this material are never likely to be available since oil palm nut shells constitute a valuable part of the fuel supply for the estate factory.

When such materials are heated in a closed space in the absence of air decomposition ensues resulting in the formation of charcoal and in the evolution of large quantities of volatile products which can be recovered only by using an efficient retort and condensing plant.

If charcoal alone is required it is sufficient to carbonise the shells in a stack or pit. The enclosed heap is fired and when the shells are thoroughly burning the supply of air is cut off, carbonisation proceeding without further combustion. This primitive method is capable of producing good charcoal.

On certain coconut estates this method is simplified still further by merely throwing water on a burning heap of shells. This results, however, in a charcoal which is not uniform and is of an inferior quality.

Coconut charcoal is used on estates as a fuel in suction gas engines, but on account of the dust associated with the char-

coal special scrubbers are desirable to purify the gas before admitting to the cylinders in order to avoid pitting.

Apart from this use there is only a very limited demand for either of these charcoals, the two main uses being as decolourising agents for liquids and absorbents for noxious gases. For example, during the Great War coconut shell charcoal was used on an enormous scale in the filling of respirators, but naturally this demand has now shrunk to very small limits.

Description of Plant and Process.

The plant in which the experiments were conducted consists of a cylindrical iron retort closed by an iron door, the retort being mounted horizontally in a brick-work chamber and heated by the hot gases from the furnace below.

The retort is 3 ft. in length and 2 ft. in diameter and holds from 250 to 300 lbs of material.

From the top of the retort a horizontal pipe leads to a water-cooled vertical condenser, from which there is an ascending pipe to carry away the non-condensible gases for combustion in the furnace. Such an arrangement suffices to recover all condensible products.

When carrying out a carbonisation, distillation commences from 2 to 3 hours after firing and frequently continues for as long as 30 hours. At the commencement the distillate consists principally of water but, as carbonisation proceeds, increasing quantities of other substances, partly in solution and partly in suspension, distil over with the water. Tar passes over in suspension during the later stages settling out when the condensed liquid is allowed to stand.

The dissolved substances consist chiefly of acetic acid, methyl alcohol (wood spirit) together with much smaller quantities of more or less complex organic substances, for example, aldehydes and phenols. This crude liquid is usually termed pyroligneous acid.

Treatment of Distillate.

Although it will be realised that the separation of pure products from the distillate is a matter of specialised technique

it may be interesting to describe briefly the general method employed.

After mechanical separation of the tar the pyroligneous acid is redistilled from a still in order to eliminate dissolved tar and tarry condensation products, the residue in the still being completely freed from acetic acid by the injection of steam. The redistilled liquid, which contains all the acetic acid and methyl alcohol, is neutralised with lime and partially redistilled to recover the methyl alcohol, leaving the acetate of lime in solution. The latter is evaporated to dryness in pans, the residue forming the commercial product known as grey acetate of lime.

To prepare acetic acid this material is treated in a special still with sulphuric acid and the crude acetic acid distilling over further purified by rectification.

The weak solution of methyl alcohol is rectified, the resulting spirit being further purified by treatment with caustic soda. In this way wood spirit, which is almost water-free and which contains no impurity other than a small proportion of acetone, can be recovered. A small quantity of wood oil separates during the rectification of the crude methyl alcohol solution but this oil is of little importance.

An outstanding feature of the tar is its fluidity due to the presence of much higher proportions of valuable liquid products than are found for example in wood tar.

The tar is heated in an iron retort fitted with a condenser. Water held in suspension distils first, then a quantity of clear red oil, leaving a small residue of pitch in the retort. The pitch has no value other than as fuel.

The oil which consists principally of phenols, commonly described as creosote, yields after purification with caustic soda an almost colourless liquid.

Results of Experimental Distillations.

The following table gives the results of two distillations carried out in the experimental plant described previously. In order to make the table as simple as possible the figures have been calculated to show the amounts of the various pro-

ducts derived from 100 lbs. of shells although in both cases the amount of material distilled was approximately 300 lbs.

Nature of Product.	Coconut palm shells.	Oil palm nut shells.
Charcoal ...	49.0 lbs.	33.4 lbs.
Pyroligneous Acid ...	2.88 gallons	3.14 gallons
Tar ...	0.26 gallon	0.43 gallon
Pyroligneous Acid		
Acetic acid (calculated) ...	4.68 lbs.	3.38 lbs.
Methyl Alcohol (Wood Spirit) ...	0.07 gallon	0.04 gallon
Tar		
Crude creosote oil ...	0.13 gallon	0.19 gallon

It must be understood that the above figures can only be regarded as a guide to the amounts of the various products that would be ordinarily obtained, these amounts being dependent both on the original moisture content of the shells and the manner of firing the retort.

Description of Charcoals.

Coconut charcoal is hard and brittle; the outside surface is dull on account of the charred fibrous layer, but the broken surface is glossy. Pieces of coconut charcoal properly carbonised emit a ringing sound when dropped on a hard surface, but imperfectly carbonised material found among the estate product gives a dull sound. The specific gravity of coconut charcoal varies from 1.17 to 1.21, compared with 1.30 for the original shell (water = 1).

Oil palm nut charcoal resembles coconut charcoal externally, but exhibits a much more glossy appearance when fractured. A remarkable feature of this charcoal is its high specific gravity which reaches 1.47 compared with 1.30 for the original shell (water = 1).

Remarks and Conclusions.

The results of the experiments show that coconut shells give a higher yield of charcoal than oil palm nut shells, which in turn give a higher yield than hard woods, such as mangrove, the average figure for the latter being 25 per cent.

Coconut charcoal offered for sale in the local market competes with imported and local mangrove charcoal. Some samples of estate coconut charcoal compare unfavourably in quality with the wood charcoal, although since coconut shells are in reality a waste product the resultant charcoal can be sold at a lower price. An improvement in the method of carbonisation is therefore the only means of producing a charcoal of uniform superior quality.

Although several bye-products from the destructive distillation of these shells can be recovered as described it is not suggested that these products can be marketed on a small scale. The initial cost of a plant would be considerable and further the same products are already being manufactured for export on a large scale in other countries.

Apart from this consideration coconut shells form a valuable source of supply of acetic acid, creosote for wood preservation, and wood spirit for use either as a denaturant for alcohol or in the preparation of pure methyl alcohol.

Oil palm nut shells give a higher yield of creosote but as stated before these shells are unlikely to be available in any quantity for destructive distillation.

In conclusion the writers wish to acknowledge the assistance received from the Manager of Chersonese Estate, Kuala Kurau, Mr. H. Hansen of Teluk Merbau Estate, Sepang, and Mr. E. A. O. Simpson of Elmina Estate, Sungei Buloh for supplies of material for distillation.

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Physomerus grossipes F. (Coreidae. Hemiptera-Heteroptera). A Pest of Convolvulaceae and Leguminosae.

BY

N. C. E. Miller.

Physomerus grossipes F. a member of the family Coreidae, of the Order Hemiptera-Heteroptera is an abundant species in Malaya where it is found on Convolvulaceous and Leguminous plants.

The gregarious habits of this "bug" throughout the life cycle render it conspicuous, and, in addition, greatly facilitate control.

When it occurs in large numbers, the damage caused by its method of feeding,—i.e. piercing the stems and sucking the juices—is considerable, for plants thus attacked, speedily wilt and wither, while fruits fail to develop, or decompose before reaching maturity.

Distribution.

This insect has been recorded from the following localities:—

Dist. Bengal; Calcutta; Moorshedabad, (Ind. Mus.); Sikhim; Assam; Margherita, (Atkinson Coll.); Khasi Hills (Chennell); Bombay, (Leith); Ceylon, (Dohrn); Nicobar Islands, Camorta (Coll Dist.): Burma; Metanja, Palon, (Fea); Malayan Archipelago (1).

Host Plants.

The following plants of which the Malay names of some are given in brackets, are attacked by both nymphs and adults:—

Morning Glory *Ipomaea purpurea* Roth. Sweet Potato *Ipomaea Batatas* Lam. (Keledek), *Ipomaea reptans* Poir. (Kang Kong); Cowpea, *Vigna Catjang* Walp. (Kachang merah, K. panjang, K. tange, K. perut ayam, K. puteh); *Clitoria Ternatea* L. (Bunga biru, Kachang telang) and French bean

Phaseolus vulgaris (Kachang bunchis, K. pendek) (2). It has also been recorded on *Citrus* sp. (Limau), but the evidence of its actually feeding on this plant is not reliable. The writer has frequently noticed, in the field, that *P. grossipes* will oviposit on plants which are definitely not its foodplants, and also on other objects such as tree trunks or wooden palings. Possibly therefore it has happened that this plant has been added to the list of previously recorded foodplants of *P. grossipes* merely because its ova have been found thereon.

Description.

Ovum. (Fig. 1.) When first deposited, the colour of the ovum is pale greenish copper, becoming dark bronze green shortly afterwards.

Fig. 1. Ova. Natural size 1.60 mm. × 1.00 mm.

The surface is shining and strongly reticulate, except near the micropylar area, where it is almost smooth.

The shape is irregularly ovate. The ovum is flattened on the side in contact with the surface on which it is laid. The flattened surface has a feeble, longitudinal depression.

Length 1.60 mm. width 1.0 mm.

1st. instar Nymph. (Fig. 2.) Antennae ferrugineous, with the apex of each segment paler; apical segment with a dense pale brownish pubescence.

Eyes, dark brick red.

Vertex, clypeus shining olive green; ventral surface of head pale greenish amber; rostrum pale amber, with the apex of the segments dark brown; epicranial suture pale amber.

Nota dark shining olive green, with the median suture pale amber; sternites pale amber, suffused with olive green.

Segments 1, 2, and 3 of the abdomen dorsally greenish ochraceous with a pale reddish suffusion, and a somewhat indistinct median longitudinal reddish stripe; remaining segments greenish ochraceous with a reddish or reddish orange suffusion. Dorsal plates brown. Segments 1 and 2 of the abdomen ventrally pale greenish ochraceous; remaining segments pale greenish ochraceous with a faint reddish suffusion; spiracular area reddish orange; spiracles ferrugineous.

Fig. 2. 1st instar nymph. Natural size 2.50 mm.

Legs pale olive green, irregularly suffused with dark olive green.

Elongate, elliptical. Apical segment of antennae fusiform, finely pubescent; all segments of the antennae with scattered setae; basal segment feebly curved.

Legs moderately robust and setose; femora feebly tuberculate on the anterior margin near the apex.

Head and body feebly setose; pronotum with a median tubercle on the anterior margin; rostrum reaching to the middle of the posterior coxae.

Total length 2.5 mm.

Length of antennal segments.

1.	2.	3.	4.
.50 mm.	.70 mm.	.65 mm.	.75 mm.

2nd. instar Nymph. (Fig. 3.) Segments 1, 2 and 3 of the antennae shining black with the base and apex narrowly pale ochraceous; apical segment black with a fine pale brown pubescence.

Eyes dark red.

Clypeus, and antenniferous projections dark shining olive green; vertex ochraceous, with a faint reddish suffusion; epicranial suture dark olive green.

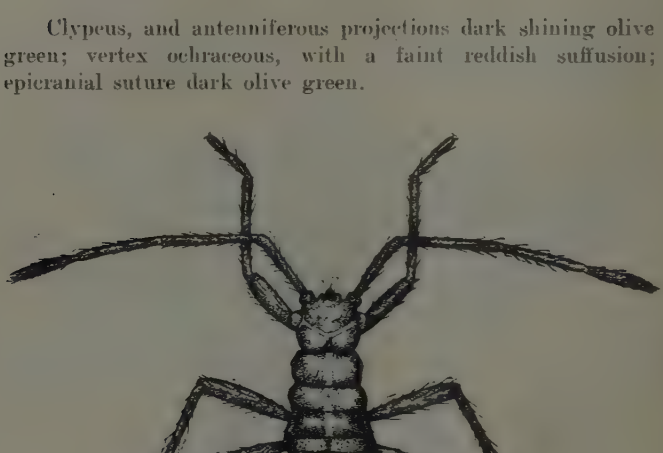


Fig. 3. 2nd instar nymph. Natural size 3.00 mm.

Pro and mesonotum ochraceous with a pale ochraceous median longitudinal suture and a faint olive green suffusion: metanotum shining dark olive green with the median suture pale ochraceous, and with the lateral margins ochraceous: median tubercle on pronotum shining black: pro and meso

sternum pale greenish ochraceous; metasternum shining olive green.

Abdomen dorsally pale greenish ochraceous, with an ochraceous patch around the dorsal plates, and with an irregular reddish maculation and suffusion and a median longitudinal reddish stripe; connexivum ochraceous; dorsal plates shining black.

Ventral surface of head ochraceous or greenish ochraceous.

Ventral surface of abdomen ochraceous with a fine and irregular reddish maculation; spiracles dark ferrugineous.

Rostrum pale greenish ochraceous with the apical segment broadly suffused with dark olive green apically, and the remaining segments with a faint olive green suffusion apically.

Coxae greenish ochraceous with the outer apical margin faintly reddish; trochanters shining olive green; legs dark greenish black.

Similar in shape to the 1st. instar nymph.

Total Length 3 mm.

Length of antennal segments.

1.	2.	3.	4.
.85 mm.	1.10 mm.	1.00 mm.	1.00 mm.

3rd. instar Nymph. (Fig. 4.) Immediately after ecdysis the colouration of the nymph in this instar is, as follows.– Antennae, rostrum and legs violaceous. Head and body very pale violaceous. In an hour or so the nymph assumes the following colours.

Apical segment of antennae dark ferrugineous; 1st. 2nd. and 3rd. segments of antennae shining dark blackish brown.

Eyes dark crimson.

Clypeus, antenniferous projections, anterior area of vertex shining black; posterior area of vertex light brown; epicranial suture whitish, with the lateral arms suffused with light brown; rostrum pale whitish brown, irregularly suffused with dark brown.

Tubercle on the anterior margin of the pronotum, black; pronotum pale reddish brown almost entirely suffused with black, and with the lateral and posterior margins black; median sulcus pale brownish white; mesonotum light reddish brown with a blackish ovate marking; median sulcus whitish faintly maculate with ferrugineous; metanotum blackish, with the lateral areas pale reddish brown; median sulcus whitish, irregularly and somewhat faintly maculate with ferrugineous,

Abdomen dorsally whitish, with the connexivum pale reddish brown, the dorso-lateral area suffused with bluish grey, and the whole surface irregularly spotted with ferrugineous; segments 1 - 4 and 6 and 7 with a moderately broad, ill defined median longitudinal ferrugineous stripe; segments 8, 9 and 10 dark brown; dorsal plates blackish with an orange and reddish orange suffusion on the anterior margin; ventral surface of abdomen whitish, suffused with bluish grey and strongly and irregularly maculate with ferrugineous;

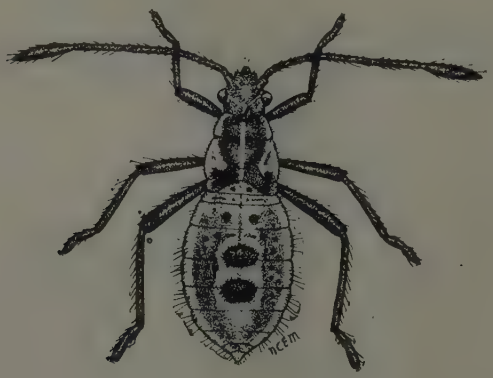


Fig. 4. 3rd instar nymph. Natural size 7.00 mm.

Sternites whitish, suffused with pink.

Legs dark shining blackish brown. Head, body, legs and antennae with scattered short setae many of which on the head and body are covered with a white wax like substance.

In this instar, the rudiments of the hemelytra and wings are perceptible, otherwise there are only slight differences between it and the preceding instar. The 1st. segment of the

abdomen is well covered, laterally, by the developing wings, and the rudiments of the scutellum are to be seen.

Total length. 7 mm.

Length of antennal segments.

1.	2.	3.	4.
1.20 mm.	1.60 mm.	1.30 mm.	1.20 mm.

4th. instar Nymph. (Fig. 5.) Antennae and legs dark shining blackish brown.

Eyes dark crimson.

Head and dorsal surface of thorax and abdomen black: connexivum pale reddish orange.

Ventral surface of thorax and abdomen black, with a dull gloss; body strongly setose, most of the setae being covered with a white wax like substance.

Fig. 5. 4th instar nymph. Natural size 7.90 mm.

The rudiments of the hemelytra in this instar are well defined, and reach just beyond the posterior margin of the 2nd. abdominal segment. The developing wings are almost concealed by the hemelytra. The tubercle on the anterior margin of the pronotum is considerably reduced.

Total length 7.90 mm.

Length of antennal segments.

1.	2.	3.	4.
1.60 mm.	2.30 mm.	1.90 mm.	1.70 mm.

5th. instar Nymph. (Fig. 6.) Shortly after ecdysis the antennae are violaceous; head dark greyish green; epicranial suture pale greenish; vertex with a median longitudinal pale greenish stripe before the epicranial suture.

Fig. 6. 5th instar nymph. Natural size 12.50 mm.

Eyes dark ferrugineous.

Pronotum greyish with an orange suffusion on the posterior half laterally; median suture pale orange; mesonotum greyish with the median suture whitish; pro and mesonota with an irregular red maculation.

Rudiments of hemelytra dark olive green, with the outer margins pale orange and the inner margins irregularly suffused with pale greenish ochraceous.

Rudiments of wings dark olive green.

Abdomen dorsally greyish; connexivum orange; dorsolateral area dark bluish grey; tubercles dark red; dorsal plates brownish orange.

Sternites whitish with a fine reddish maculation.

Ventral surface of abdomen greyish, darker near connexivum; segment 6 to apical segment dark grey; tubercles dark red.

After a few hours the colouration of the nymph becomes much darker dorsally.

Ventrally the darkening is not so pronounced.

The rudiments of the hemelytra reach almost to the posterior margin of the 4th. abdominal segment. The posterior femora are more incrassate and tuberculate than in the previous instar, and the tubercle on the anterior margin of the pronotum is absent. The rostrum reaches to the base of the 1st. abdominal segment.

Total length. 12.50 mm.

Length of antennal segments.

1.	2.	3.	4.
2.30 mm.	2.60 mm.	3.10 mm.	2.30 mm.

Adult. Male. (Fig. 7.) Antennae dark blackish brown; Eyes dark brown.

Head dark blackish brown with a faint and irregular light brown suffusion on the vertex; rostrum dark blackish brown.

Pronotum black with a median longitudinal light reddish brown stripe which is more pronounced on the basal two thirds: lateral margins narrowly and almost entirely light brown or reddish brown.

Scutellum black, with the apex light brown, the lateral margins dark brown and with a light brown median longitudinal stripe on the basal half.

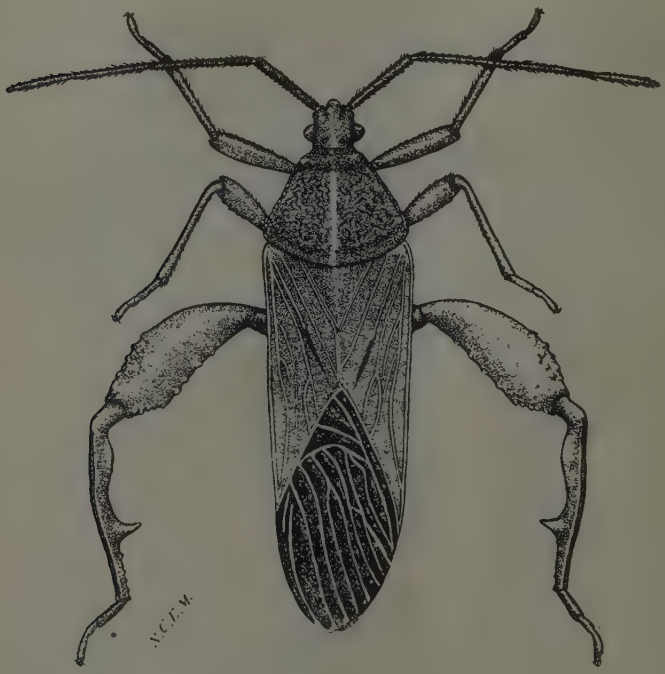
Meso and metanota pale shining brown.

Sternites blackish brown, with shining black tubercles.

Abdomen dorsally brownish orange with an irregular dark brown suffusion and with the 7th. segment almost entirely black; connexivum pale brownish orange; ventral surface of abdomen blackish brown; with the connexivum light brown.

Tubercles on ventral surface of abdomen shining piceous; spiracles black.

Legs shining black, with a light brown pubescence.



(Fig. 7.)

Outer and apical margin of corium and basal margin of clavus light brown; corium and clavus dark blackish brown; membrane dark infumate with a faint iridescence.

Wings dark purplish black with the basal half of the costa light brown and the connecting membrane shining reddish orange.

The whole insect except the dorsal surface of the abdomen, membrane of hemelytra and wings, with the pubescence covered with a whitish wax-like substance giving it a greyish appearance.

Basal segment of antennae thicker than remaining segments. Dorsal surface of pronotum rugose and tuberculate.

Sternites rugulose with scattered rounded and flattened tubercles.

Ventral surface of abdomen finely rugulose, tuberculate; segments 2 and 3 with a number of large mucronate tubercles irregularly disposed with the apices inclined towards the apex of the abdomen.

Tibiae of anterior and median legs somewhat compressed laterally, and with a feeble sulcus along the anterior surface; posterior femora strongly incrassate and irregularly tuberculate on the anterior and lower surface, the tubercles being more pronounced and in some cases mucronate, near the apex; posterior tibiae sinuate, laterally compressed, with a sulcus along the anterior surface and with a robust spine about half-way along the inner margin. Below this spine is a shorter spine, and thence the inner margin is spinose to the apex.

Dorsal surface of the abdomen smooth. The dorsal plates which were prominent in the nymphal stages are now flattened and have the appearance of integumental folds.

Rostrum reaching median coxae in some individuals. Occasionally it reaches about half way between anterior a median coxae.

Adult. Female. Similar to the male, but differs in the following respects.

The posterior femora are less robust and the tubercles less prominent.

The posterior tibiae have no median projection on the inner margin. The tubercles on the 1st. to the 3rd. segments of the abdomen ventrally are less numerous and flattened. None of the tubercles on these segments is mucronate.

Average total length.	Average length of antennal segments.			
Male.	1.	2.	3.	4.
17.20 mm.	2.82 mm.	3.70 mm.	2.73 mm.	2.62 mm.
Maximum. 21.50 mm.	3.50 mm.	4.00 mm.	2.90 mm.	2.80 mm.
Minimum. 14.00 mm.	2.40 mm.	3.00 mm.	2.10 mm.	2.30 mm.
Difference. 7.50 mm.	1.10 mm.	1.00 mm.	.80 mm.	.50 mm.
Female.				
18.03 m.m.	2.71 mm.	3.40 mm.	2.70 mm.	2.60 mm.
Maximum. 21.00 mm.	3.20 mm.	4.00 mm.	3.10 mm.	3.00 mm.
Minimum. 15.00 mm.	2.50 mm.	3.20 mm.	2.50 mm.	2.40 mm.
Difference. 6.00 mm.	.70 mm.	.80 mm.	.60 mm.	.60 mm.

Width between pronotal angles.

	Male.	Female.
Average.	5.38 mm.	5.36 mm.
Maximum.	6.00 mm.	6.20 mm.
Minimum.	4.80 mm.	4.80 mm.
Difference.	1.20 mm.	1.40 mm.

The above figures are based on the measurements of fifteen individuals.

Specimens taken in the field were slightly larger. One hundred individuals, fifty males and fifty females, were examined and the results of the measurements are given now.

Average total length. Male.	Average length of antennal segments.			
	1.	2.	3.	4.
21.52 mm.	3.32 mm.	4.11 mm.	2.98 mm.	2.87 mm.
Maximum. 22.50 mm.	4.00 mm.	4.50 mm.	3.10 mm.	3.00 mm.
Minimum. 17.00 mm.	2.90 mm.	3.40 mm.	2.50 mm.	2.30 mm.
Difference. 5.50 mm.	1.10 mm.	1.10 mm.	.60 mm.	.70 mm.

	Female.			
	21.08 mm.	3.07 mm.	3.81 mm.	2.85 mm. 2.79 mm.
Maximum.	21.80 mm.	3.50 mm.	4.00 mm.	3.00 mm. 2.90 mm.
Minimum.	19.00 mm.	2.80 mm.	3.10 mm.	2.50 mm. 2.40 mm.
Difference.	2.80 mm.	.70 mm.	.90 mm.	.50 mm. .50 mm.

Width between pronotal angles

	Male.	Female.
Average.	6.04 mm.	5.95 mm.
Maximum.	6.50 mm.	6.20 mm.
Minimum.	5.00 mm.	5.40 mm.
Difference.	1.50 mm.	.80 mm.

Life History.

The ova of *P. grossipes* are deposited in batches, in varying numbers up to one hundred or so, on the upper or lower sides of the leaves, or on the stems of the foodplants. Frequently, also, they have been discovered on other plants, in the vicinity of the foodplant.

There is generally no definite arrangement of the ova, but, it has been observed that they are sometimes deposited in narrowly separated parallel rows.

The female insect generally remains on the batch of ova, or close by, for some days after the eclosion of the nymphs, all of which crowd together on the foodplant.

The incubation period lasts from seventeen to twenty one days, the average being 17.5 days.

Under field and laboratory conditions, the gregarious habit of this bug has been observed to continue throughout life, from the day of eclosion, up to, and including the adult stage, and it is a factor which contributes to the difficulty of recording with absolute accuracy the duration of the nymphal stages, for, it was found that individuals separated from a batch and placed singly, for the purposes of observation in breeding cages or tubes died within a few days of being removed. The adults, if disturbed are able to eject from the anus an objectionable whitish yellow fluid, to a distance of a foot or so.

At the time of ecdysis, the nymph firmly attaches its legs to the plant it is feeding on, and hangs head downwards. Then, by convulsive movements, it causes the skin, which is to be got rid of, to split along the epicranium and the nota. The antennae and the anterior pair of legs are the first to be released. Then, with these legs, the bug is now able to obtain a firm hold on another part of the plant and to extricate the other pairs of legs and the abdomen.

Postembryonic development, as is usual with the Rhynchota is gradual, and, apart from the nymphs' being very pale in colour immediately following ecdysis, colour changes are not very pronounced.

The most marked change in colour takes place at the 3rd. instar.

As regards morphological changes, the most noticeable are those which take place in the fifth moult when the insect becomes adult. In this stage, the hemelytra and wings are fully developed, and, if the dorsal surface of the abdomen be examined, it will be seen, that the dorsal plates have degenerated, their former position being indicated by small integumental folds only.

Under laboratory conditions the average duration of the nymphal stages is as follows:—

1st. instar.	7.[illegible] days.
2nd. instar.	8.70 days.
3rd. instar.	8.30 days.
4th. instar.	14.60 days.
5th. instar.	22.90 days.

Adults lived for 32.3 days and the total life cycle from the ovum to the death of the adult is approximately 113 days or 16 weeks. Nine adults captured in the field lived, under laboratory conditions, an average of 30.8 days. On pages 419, 420 will be found a table giving the figures for the duration of each instar of the individuals which were reared in the laboratory, and which form the subject of the present paper.

An examination of this table shows that the greatest variations in the duration of a particular instar, are in the fourth, fifth and adult instars. Abnormally short durations of the lives of nymphs and adults are generally due to some

injury received shortly after, or during ecdysis, when the moulting insect is frequently unable, from some cause or other, to entirely free itself from the exuviae, consequently it is difficult or even impossible for it to walk about and begin to feed. If it is unable to liberate the mouth parts, of course, feeding is quite out of the question.

Adults of *P. grossipes* exhibit several characters which permit differentiation to be made between the sexes, without difficulty.

The males differ from the females, in having much more robust hind femora. The hind tibiae, on their inner surface, have a prominent spine which is not present on the hind tibiae of the female. In small male specimens the tibial spine and the hind femora are frequently feebly developed.

On the first, second and third ventral segments of the abdomen of the male (Fig. 8.) the tubercles are much more pronounced and some of them are mucronate while, in the female all the tubercles are flattened or feebly rounded.

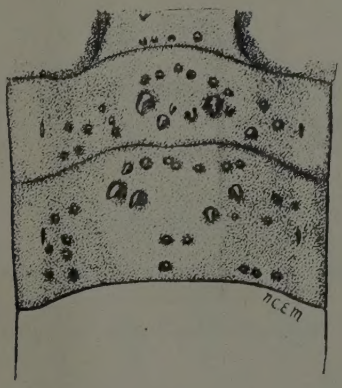


Fig. 8. Segments 1, 2 and 3 of abdomen, ventorally, of male.

Parasites.

Up to the present, only one parasite of *P. grossipes* has been recorded, but it has not yet been specifically determined. It is a Hymenopteron belonging to the superfamily Chalcidoidea.

Control.

Control measures may be directed against all stages of this insect.

The ova are conspicuous and thus may be collected and destroyed with trouble.

When the nymphs and adults are to be dealt with, it will be found that the best method is to shake them from the foodplant into large tins containing water on which is a film of kerosene.

The adults are more active during the warmer periods of the day, therefore it is advisable to start operations against them in the early morning, when they are sluggish and less ready to take to flight when disturbed.

Spraying with kerosene emulsion is also effective in destroying the nymphs and adults, but it is not recommended for bugs which are feeding on vegetables e.g. Kang-Kong, or leguminous plants of which the pods are used for human consumption.

Conclusion.

The writer is indebted to Che Mohamed Yusope for keeping the breeding registers.

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Number.	1	2	3	4	5	6	7	8	9	10	11
Sex.	♀	♀	♀	♀	♀	♀	♀	♀	♂	♀	♀
Date of oviposition	29.10.28	29.10.28	29.10.28	29 10.28	11.11.28	11.11.28	14.11.28	14.11.28	14.11.28	14.11.28	14.11.28
Date of hatching	15.11.28	15.11.28	15.11.28	15.11.28	30.11.28	30.11.28	1.12.28	1.12.28	1.12.28	1.12.28	1.12.28
Incubation period	17	17	17	17	19	19	17	17	17	17	17
Date of 1st moult	22.11.28	22.11.28	22.11.28	22.11.28	5.12.28	5.12.28	7.12.28	7.12.28	7.12.28	7.12.28	7.12.28
Period of 1st instar	7	7	7	7	5	5	6	6	6	6	6
Date of 2nd moult	3.12.28	3.12.28	3.12.28	3.12.28	14.12.28	16.12.28	14.12.28	15.12.28	15.12.28	15.12.28	15.12.28
Period of 2nd instar	11	11	11	11	9	11	7	8	8	8	8
Date of 3rd moult	10.12.28	10.12.28	10.12.28	10.12.28	19.12.28	19.12.28	21.12.28	24.12.28	24.12.28	24.12.28	24.12.28
Period of 3rd instar	7	7	7	7	5	3	7	9	9	9	9
Date of 4th moult	18.12.28	18.12.28	18.12 28	18 12.28	28.12.28	30.12.28	4. 1.29	7. 1.29	7. 1.29	7. 1.29	14. 1.29
Period of 4th instar	8	8	8	8	9	11	14	14	14	14	21
Date of 5th moult	19.1.29	21. 1.29	22. 1.29	24.1.29	29. 1.29	6. 2.29	22. 1.29	22. 1.29	22. 1.29	22. 1.29	22. 1.29
Period of 5th instar	32	34	35	37	32	37	18	15	15	15	8
Date of death of adult	25.1.29	9. 2.29	18. 2.29	18. 2.29	27. 3.29	8. 5.29	23. 1.29	29. 1.29	8. 2.29	30. 1.29	7. 5.29
Life of adult	6	19	27	25	57	91	1	7	17	8	105

Number.	12	13	14	15	16	17	18	19	20	21
Sex.	♀	♀	♀	♂	♀	♀	♀	♀	♂	♀
Date of oviposition	14.11.28	14.11.28	14.11.28	17 11.28	17.11.28	17.11.28	16.11.28	16.11.28	17.11.28	17.11.28
Date of hatching	1.12.28	1.12.28	1.12.28	3.12.28	3.12.28	3.12.28	7.12.28	7.12.28	5.12.28	5.12.28
Incubation period	17	17	17	16	16	16	21	21	18	18
Date of 1st moult	7.12.28	7.12.28	7.12.28	8.12.28	8.12.28	8.12.28	20.12.28	20.12.28	15.12.28	15.12.28
Period of 1st instar	6	6	6	5	5	5	13	13	10	10
Date of 2nd moult	15.12.28	15.12.28	16.12.28	17.12.28	17.12.28	17.12.28	24.12.28	24.12.28	25.12.28	26.12.28
Period of 2nd instar	8	8	9	9	9	9	4	4	10	11
Date of 3rd moult	24.12.28	24.12.28	24.12.28	28.12 28	28.12.28	28.12.28	30.12.28	30.12.28	29.12.28	7. 1.29
Period of 3rd instar	9	9	8	11	11	11	6	6	4	12
Date of 4th moult	14. 1.29	14. 1.29	14. 1.29	14. 1.29	14. 1.29	14. 1.29	14. 1.29	14. 1.29	26. 1.29	26. 1.29
Period of 4th instar	21	21	21	17	17	17	15	15	28	19
Date of 5th moult	22. 1.29	22. 1.29	22. 1.29	29. 1.29	4. 2.29	4. 2.29	18. 2.29	18. 2.29	21. 2.29	22. 2.29
Period of 5th instar	8	8	8	15	21	21	35	35	26	27
Date of death of adult	7. 4.29	28. 2.29	28. 2.29	27. 2.29	22. 2.29	18. 3.29	28. 2.29	28. 2.29	6. 3.29	16. 4.29
Life of adult	75	37	37	29	18	42	10	10	13	53